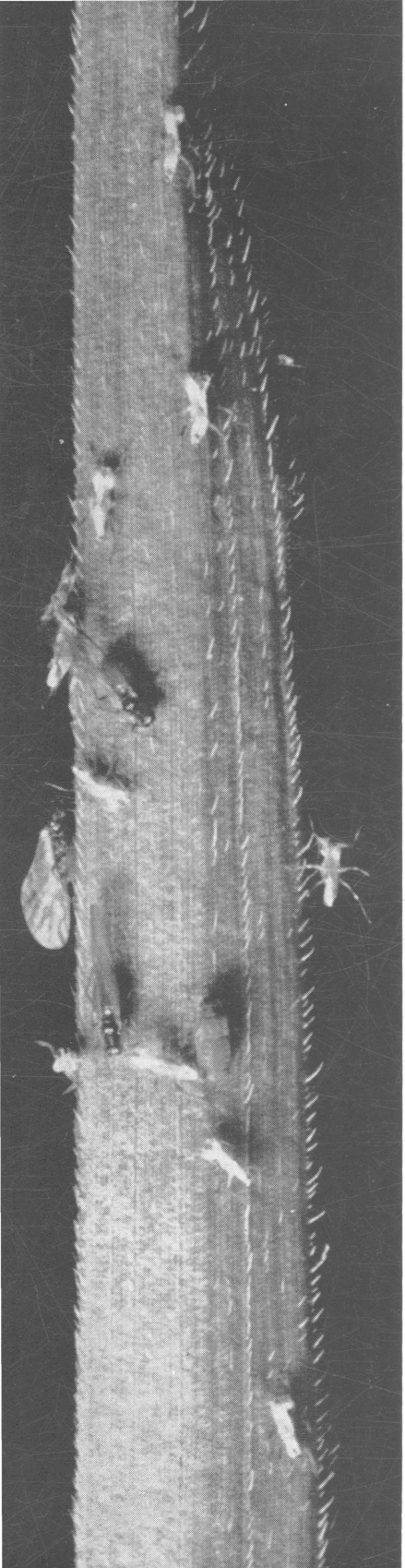

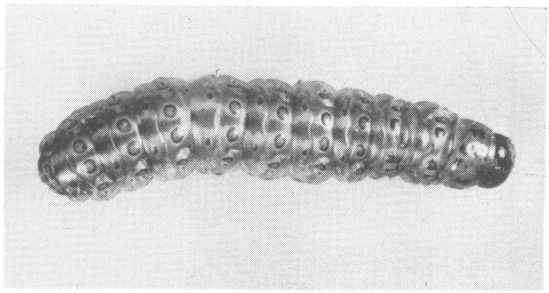

European Corn Borer and Corn Leaf Aphid Resistance in Corn Hybrids

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Research Circular 174
October 1969

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio

in cooperation with

Agricultural Research Service
U. S. Department of Agriculture

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INTRODUCTION

Damage caused by the European corn borer (ECB), *Ostrinia nubilalis* (Hubner), annually has ranged from an estimated high of more than $8.5 million (1954) to an estimated low of about $0.6 million (1965) during the last 15 years in Ohio (Fall ECB Survey of Ohio).[2] The estimated loss in 1968 was more than $7.5 million, primarily due to the second generation of corn borer. Losses of yield were due to barren stalks, broken stalks and ear shanks, and unmarketable or poor quality ears. Larvae cause these losses by making feeding holes in leaves; feeding on anthers and other parts of the tassel; tunneling and causing breakage of the leaf, ear shank, and stalk; and feeding on kernels.

The corn leaf aphid (CLA), *Rhopalosiphum maidis* (Fitch), is an economic pest of corn and has been blamed for heavy losses of corn in Ohio (5), although no monetary value has been assigned. This aphid damages corn by sucking sap and reducing the vigor of the plant, hindering pollination by preventing pollen shed, and transmitting virus diseases (2).

The amount of corn lost due to these two insects varies considerably from year to year. Variation may be attributed to several factors, such as time of planting, degree of stalk destruction from the previous year, severity of the preceding winter, amount of rainfall from the time the corn is in the whorl stage until after pollen shed, and the resistance or susceptibility of a particular corn hybrid.

Varietal resistance in corn to these insects as a practical means of control is not a new idea, although it has received more attention in the last two decades. As early as 1921, McColloch reported differences in infestation levels of the CLA on 30 varieties of corn (3). Likewise, Roubaud noted almost complete larval mortality of the ECB in one of five varieties of corn being studied (4).

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[2]This survey is conducted annually in the major corn growing areas of Ohio to estimate the population of borers and losses caused by this insect.

Many inbred lines of corn have been developed which are resistant to these insects. These inbreds have been used in developing resistant corn hybrids. However, hybrid seed corn currently being produced for farmers varies from highly resistant to one or both insects to completely susceptible to one or both species.

This circular reports an evaluation of 139 corn hybrids from 10 seed producers in 1967 and 87 hybrids in 1968 (some are the same hybrids in both years). Each hybrid was evaluated under Ohio (Wayne County) conditions for ECB resistance in 1967 and 1968 and establishment of CLA populations.[3]

EXPERIMENTAL PROCEDURE

Each producer was asked to submit seed samples of corn hybrids which he anticipated distributing in Ohio in 1967 and 1968. Three to 27 different samples were obtained from each producer (Table 1).

The corn hybrids were compared in a randomized block design, with each block replicated five times. Each block consisted of one 20-foot row of each hybrid, with 30 seeds per row.

The first ten plants of all rows were artificially infested with two European corn borer egg masses at three different times (a total of six egg masses or approximately 120 eggs per plant). As corn hybrids in the early stages of growth tend to have natural resistance to the ECB, the late-maturing hybrids were infested with two additional egg masses to insure an opportunity for infestation. To simulate a first generation infestation from a natural population, all plants evaluated in this report were artificially infested between the early whorl and late whorl stages of plant development.

The CLA populations developed from natural infestations. In general, this insect was quite abundant in Wayne County, Ohio, in 1967. Consequently, the research plots were exposed to an aphid population favorable for screening. In 1968, significant natural populations of aphids failed to develop in the test plots.

Evaluations

Resistance ratings of the various corn hybrids for the first brood ECB were made on each plot. These ratings were determined by the degree of leaf feeding as described by Guthrie et al. (1). This rating system consists of nine classes as follows:

Class 1. No visible leaf injury or a small amount of pin or fine shot-hole type of injury on a few leaves.

Class 2. Small amount of shot-hole type lesions on a few leaves.

[3]Mention of commercial products in this publication does not constitute an endorsement by the U. S. Department of Agriculture over other products not mentioned.

Class 3. Shot-hole injury common on several leaves.
Class 4. Several leaves with shot-hole injury and some elongated lesions.
Class 5. Some leaves with elongated lesions.
Class 6. Several leaves with elongated lesions (about 1 inch).
Class 7. Long lesions common on about half of the leaves.
Class 8. Long lesions common on about two-thirds of the leaves.
Class 9. Most of the leaves with long lesions.

In Table 1, these ratings have been grouped into three broader classes: resistant ratings averaging 4.0 or less; intermediate ratings which average between 4.1-6.0; susceptible ratings averaging 6.0 or above.

Aphid evaluations were determined by the population density on each of the various hybrids (all plants in each plot were observed). The following four classes were used in rating aphid populations established at or above the flag leaf.

0—no visible establishment of aphids.
<5—aphids present with no heavy population or less than 5% of the plants with heavy populations.
5-15—5-15% of plants with heavy populations.
15+—more than 15% of plants with heavy populations.

Corn hybrids receiving ratings of 15+ are considered quite susceptible to the CLA.

RESULTS

The degree of resistance to ECB and CLA exhibited by the various corn hybrids is reported in Table 1.

Of the 139 hybrids included in the 1967 experiment, 15.1% were resistant (R), 64.7% intermediate (I), and 20.1% susceptible (S) to the ECB. In 1968, the 87 hybrids were rated 3.4% R, 75.9% I, and 20.7% S. This indicates that 80% of these hybrids have some resistance.

Approximately 64% of the hybrids in 1967 had 15% or less of the plants heavily infested with CLA. The remaining 36% of the hybrids had more than 15% of the plants heavily infested and are considered susceptible to this insect.

DISCUSSION

The evaluations presented in Table 1 should be used as an aid rather than the sole criterion for selection of seed corn. Emphasis on these data should be proportionate to the amount of injury anticipated from first generation ECB and CLA. Other agronomic factors, such as adaptability, yield potential, stand count, and resistance to other pests and diseases, must be weighed against the potential loss from ECB and

CLA infestations. Many hybrids have desirable agronomic attributes and also are resistant to these two insects.

The data in Table 1 show the reaction of hybrids to a first generation infestation by the ECB. Inbred lines and hybrids which are resistant to a first generation infestation are not necessarily resistant to a second generation infestation.

It should be noted that the ratings are subject to some change in different years (Table 1) and in different areas. Environmental factors will vary and consequently some responses of both the insects and plants may be different.

Some degree of caution should be used in interpreting the CLA ratings, since the use of natural infestations may have permitted some escapes (plants not exposed to aphids). Although the number of escapes was probably minimal due to the heavy natural population of this aphid in this study in 1967, some hybrids may have been rated favorable (no infestation), even though they were actually susceptible.

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TABLE 1.—Evaluations of Corn Hybrids Grown at Wooster, Ohio, in 1967 and 1968 for Resistance to First Generation Infestation by the European Corn Borer (ECB) and Corn Leaf Aphid (CLA).

Hybrid	ECB Resistance* 1967	ECB Resistance* 1968	CLA Population†
Anderson			
Ax3	I (5.2)	I (5.0)	<5
Ax5	I (4.4)	I (5.0)	5-15
Ax9	S (6.4)	S (7.4)	<5
A90	S (7.2)	S (6.8)	<5
A95	S (6.6)	I (5.2)	5-15
A100	I (5.4)	S (6.4)	5-15
A104	I (5.2)	I (5.8)	<5
A105	I (5.8)	S (6.6)	5-15
A110-A	I (4.6)	—	15+
A110-B	—	I (5.4)	—
A111	I (5.2)	—	5-15
A112	S (6.2)	—	5-15
A120	I (5.8)	—	15+
3W-100	—	I (4.2)	—
3W-105	I (5.4)	S (6.6)	5-15
3W-110	—	I (5.0)	—
Silo filler	S (6.4)	S (7.6)	0
Crow			
206	—	I (5.6)	—
226	—	I (5.0)	—
416	—	S (8.0)	—
420	S (6.6)	S (7.0)	15+
428	R (3.6)	I (4.4)	15+
463	—	I (5.8)	—
551	—	R (3.8)	—
722	I (4.6)	I (5.6)	5-15
806	—	I (5.2)	—
DeKalb			
XL45	I (4.2)	—	5-15
XL342	S (6.4)	—	15+
XL346	I (5.2)	—	5-15
XL361	R (3.2)	—	5-15
XL362	I (5.8)	—	<5
XT606	R (3.6)	—	5-15
XT872	I (4.4)	—	5-15
441	I (5.6)	—	15+
640	I (5.0)	—	5-15
874	I (4.6)	—	15+
Funk			
G-17A	I (5.8)	—	0
G-18A	I (5.0)	—	<5
G-38	I (5.2)	—	15+
Funk			
G-44	S (6.2)	—	5-15
G-4222	—	I (5.0)	—
G-4289	—	I (4.8)	—
G-4333	—	I (4.4)	—
G-4355	I (4.8)	—	5-15
G-4384	I (4.6)	I (5.6)	15+
G-4390	I (4.8)	—	5-15
G-4401	S (8.6)	—	15+
G-4411	—	R (3.0)	—
G-4464	I (5.4)	—	<5
G-4473	R (3.8)	I (5.2)	<5
G-4474	I (5.0)	—	15+
G-4476	R (3.0)	I (4.6)	<5
G-4545	R (3.8)	—	<5
G-4566	I (4.2)	I (5.2)	5-15
G-4601	I (6.0)	—	15+
G-4641	I (4.2)	I (5.0)	15+
G-4644	I (5.6)	I (6.0)	15+
G-4697	I (4.8)	I (5.8)	15+
G-5207	—	I (5.6)	—
18467	—	I (4.2)	—
Moews			
M16	S (6.4)	—	15+
M516	I (5.6)	S (6.6)	5-15
M530	S (7.2	—	15+
M535	I (5.8)	S (6.2)	5-15
SM3	R (3.8)	I (5.2)	5-15
SM3B	R (3.4)	I (5.2)	15+
SM6	S (7.8)	—	15+
SM44	I (4.2)	I (5.2)	5-15
SM55A	I (5.0)	I (5.2)	5-15
SM70	I (4.4)	—	15+
SM327	—	I (4.6)	—
SM337	—	I (5.4)	—
SM338	—	S (6.2)	—
SM627	—	S (7.4)	—
Ohio			
524	I (5.4)	I (4.8)	0
535	I (4.6)	I (4.6)	0
636	I (4.4)	R (4.0)	5-15
708	I (4.2)	I (5.0)	5-15
710	R (3.6)	I (4.8)	0
760	I (4.6)	I (5.2)	5-15

*R=resistant, I=intermediate, S=susceptible; —=no data obtained; numbers in parentheses ( ) are average numerical ratings of hybrids.

†Percent of heavily infested plants.

TABLE 1 (continued).—Evaluations of Corn Hybrids Grown at Wooster, Ohio, in 1967 and 1968 for Resistance to First Generation Infestation by the European Corn Borer (ECB) and Corn Leaf Aphid (CLA).

Hybrid	ECB Resistance* 1967	ECB Resistance* 1968	CLA Population†
Ohio			
823	R (3.4)	I (4.6)	5-15
824	R (3.2)	I (4.2)	5-15
825	R (3.0)	I (4.2)	<5
826	I (4.2)	I (4.6)	<5
827	I (5.8)	I (5.8)	15+
Pa555	I (5.0)	I (5.0)	<5
O-Y-O			
121	I (5.8)	I (4.6)	<5
130A	I (4.4)	I (4.6)	<5
135	R (3.8)	I (4.4)	5-15
225	I (5.4)	I (5.4)	15+
240	S (6.6)	—	15+
333	—	I (5.2)	—
335	S (7.8)	S (6.4)	5-15
360	I (4.6)	I (5.2)	<5
380	I (4.4)	—	5-15
410A	S (7.2)	—	0
425	I (4.8)	I (5.4)	<5
435	S (6.2)	—	5-15
435A	I (6.0)	—	5-15
455	I (5.8)	—	15+
470	R (3.8)	—	<5
501	I (4.8)	—	15+
66-33	I (4.2)	—	0
Pioneer			
318A	S (6.4)	—	15+
321	—	I (5.6)	—
325A	S (6.8)	I (5.2)	15+
345A	I (5.0	—	15+
354A	S (6.4)	—	15+
350D	S (6.8)	—	15+
362	S (7.4)	—	15+
368	I (5.0)	—	5-15
371	I (5.2)	I (5.2)	15+
3280	I (5.0)	—	15+
3304	S (7.6)	I (5.8)	15+
3306	I (4.2)	I (5.0)	5-15
3369	I (5.2)	—	<5
3414	I (5.2)	I (5.0)	15+
3466	I (4.4)	I (4.4)	5-15
3481	I (5.2)	I (5.6)	15+
3505	—	S (6.8)	—
3510	I (5.0)	—	15+
3519	I (4.4)	—	<5
3524	R (4.0)	—	5-15
Pioneer			
3550	I (6.0)	—	15+
3567	R (4.0)	I (4.2)	<5
3580	I (5.4)	—	5-15
3658	I (5.0)	—	5-15
3675	I (5.2)	—	<5
3715	I (4.6)	I (5.0)	15+
3773	I (4.4)	—	<5
3775	I (4.8)	I (5.2)	<5
7278	I (5.8)	—	5-15
X6066	—	S (6.2)	—
P-A-G			
SX7	—	I (4.8)	—
SX9	R (4.0)	I (5.8)	<5
SX19	R (3.4)	—	5-15
SX29	I (4.4)	S (6.4)	5-15
SX31	I (4.4)	I (5.4)	5-15
SX36	S (7.8)	S (8.6)	15+
SX49	I (4.8)	—	15+
SX52	I (4.8)	I (4.8)	5-15
SX310	S (6.8)	—	<5
62MFC	S (6.6)	—	5-15
45	S (6.4)	—	15+
70	I (5.6)	—	5-15
272	I (4.8)	—	5-15
285	S (6.2)	—	15+
313	I (6.0)	S (7.4)	5-15
395	I (5.4)	I (6.0)	15+
399	I (5.6)	I (5.6)	15+
434	I (5.2)	—	15+
437	I (4.8)	—	<5
Marsh			
320	I (5.6)	—	<5
214A	I (5.6)	—	15+
219A	I (5.2)	—	15+
437A	S (6.4)	—	15+
643A	I (5.6)	—	5-15
673A	I (4.6)	—	5-15
3X29	I (4.4)	—	15+
S23	R (3.8)	—	—
S28	R (3.4)	—	<5
S41	R (4.0)	—	<5
S47A	I (4.4)	—	5-15

*R=resistant, I=intermediate, S=susceptible; —=no data obtained; numbers in parentheses ( ) are average numerical ratings of hybrids.

†Percent of heavily infested plants.